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Analysis of Irrigation Water Quality in Silifke-Mersin Province, Turkey

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***Abstract*— This study was performed to identify the irrigation water quality of groundwater resources used in irrigation of some vegetable plants and their effect on soil salinity at plastic houses. Water samples were taken from groundwater resources. In addition, soil samples were taken from the research sites at 0-30 cm soil depth for determination of chemical and physical properties of research soils. In results, soil textures varied from Sandy-Clay-Loam (SCL) to Loam (L). The pH and Electrical Conductivity, EC, of soils within the plastic houses varied from 7.36 to 7.66 and from 375 to 3449 µmhos/cm, respectively. Those parameters for water samples varied from 7.15 to 8.03 and from 437 to 2103 µmhos/cm, respectively. In accordance of United State Salinity Laboratory standard, irrigation water quality was found as C2 (Moderate Saline Water) and C3 (High Saline Water). In general, salinity levels of irrigation water were high and possible reason behind that groundwater could be affected from high saline seawater interactions that are nearby the wells.**

***Index Terms*— Water quality, Groundwater, Vegetables, Salinity, Soils.**

I. INTRODUCTION

The world has been surrounded by water about 70%, and is known blue planet in accordance of view. Water is the highest element among the others in the world. About 97.5 % of water is in the sea or oceans with saline characteristics.

Annual rainfall is about 643 mm and yields about 501 billion m^3 water in Turkey. Total annual available surface and groundwater potential of Turkey are about 12 and 98 billion m^3, respectively with a total of 110 billion m^3 [1]. One of the most important limitations for crop production in water shortage climate is low rainfall amount and its uneven distribution through the year. The time of the rainfall is very important role to play in water-limited regions for agro-production since even little late coming rainfall may have notable reduction in crop yield [2]. Around 70% of the fresh water resources have been used in irrigation in Turkey [3] and agriculture is the maximum water user sector with this present status and one of the most important issue in water-starved environments is efficient use of water particularly groundwater resources. Growing of low water consuming crops or planning of crop patterns in accordance of current water supply are strongly recommended particularly for such regions [4-7]. Crop production has limited under the conditions of water deficiency through the root zone [8]. Irrigation is technological practice improving the crop yield as well as quality under the correct management [9]. In order to obtain maximum profits from the current water supplies, special cares are needed especially in the water distribution and water use in field level [10]. Irrigation is vital important to improve the crop production in arid or semi-arid lands. In most parts of the Turkey such Konya plain, it is impossible to obtain economical crop yields without irrigation even for winter cereals. Therefore, water resources in such regions have to be managed properly for sustainable agricultural water management [11]. Correct irrigation program, application of right amount of water with suitable irrigation interval, is needed to success the maximum crop yields or better income. Full irrigation is strongly recommended for only water rich environments [12].

In order to improve agro-production in unit area, one-way is protected or greenhouse culture. Silifke-Mersin province of Turkey, our research region, has great interest about vegetable production in plastic houses. Total land size of plastic houses is about 150 hectare [13].

As we all know that farming within the green houses are very important role to play increasing the income of farmers from the small-sized lands. Since, It is possible to get more and qualified production or better income from protected cultivation under well management. One of the most important advantages of vegetable growing within the plastic house, we may grow the vegetables inside the green houses when outside temperature is very low. Due to the reliable earnings from the small-sized farms, green house production seems necessarily prerequisites for regions.

In protected cultivation, drip-irrigated vegetable crops are great interests due to the having number advantages of that system such as uniform water application to the vegetables, improving the fertilizer efficiency due to the application fertilizer with liquid form to the only root zone and obtaining very qualified yields resulting from the control the all the inputs with great care. On the other hand, the most important component of drip system is emitters and they may be clogged easy from poor quality irrigation water supply. Therefore, irrigation water quality vital important role to play in selection of irrigation method particularly for drip irrigation system.

In greenhouses, salinity is the common problem and main cause of salts within the root zone is using poor quality irrigation water. Irrigation water quality has direct effects on crop yield or product quality [14]. Acar et al. [15] underlined the importance of the efficient drainage systems in protected cultivation for facilitating the optimum salt balance through

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the crop zone depth. They stated that the main reason of salinity in green house is no drainage systems in those environments. They suggested that one way to minimize or complete solving the salinity problems in green house is diverting the rainfall through the greenhouse for leach away soluble salts lower parts of the root zone in none-production periods. Sonmez et al. [16] research the salinity levels of both irrigation water and soil for 28 greenhouses in Demre-Antalya province of Turkey. They found that in general irrigation water quality varied from moderate (second class) to high (third class) saline water. Soil salinity level varied from moderate to high saline in examines the 0-40 cm soil depth. Al-Zarah [17] studied about the groundwater quality by using water samples taken from the 101 wells in Saudi Arabia. He stated that water quality varied from C_3S_1 (Third class in salinity and first class in alkalinity problem) to C_4S_2 depending on the season. He suggested that crop patterns should be chosen in accordance of irrigation water quality. Riaz et al. [18] reported that dilution with fresh surface water with poor quality irrigation water and growing crops with highly resistant to salinity are reliable solution in using the unfit irrigation water. Beside this, well management of soils is necessary for obtaining higher and qualified yield in such environments. The aim of the present study is, therefore, to examine irrigation water quality parameters of groundwater using irrigation of vegetables in plastic houses for Silifke-Mersin province of Turkey.

II. MATERIALS AND METHOMMHOS/CM

The stud was performed at Silifke-Mersin province of Turkey. The monthly water samples were taken from the 10 deep wells. The research periods were between October 2011 and May 2012. Soil samples were taken from the root zone of vegetables for determining the effect of water quality on soil salinity.

Silifke province is situated at 36° 22' N latitude and 33° 56' E longitude. The land size is about 295 ha and is surrounded by Erdemli town in East , Gulnar and Mut towns in West, Karaman city in North. It is about 15 m above the sea level [19]. Silifke is characterized as semi-arid climate within the Mediterranean region; hot and drought in summers and warm and rainy in winters [20]. Mean annual precipitation is around 572 mm and maximum rainfall has observed as 120 mm in December [13]. As stated above, research site is about 295 ha but only 66 ha have been used in production. The major incomes of people in region are greenhouse production followed by animal breeding and tourism [19]. Water samples from representing 10 deep wells at the Silifke province were collected during the periods October 2011 - May 2012 and analyzed for various physic-chemical properties such as pH, electrical conductivity (EC), sodium adsorption ratio (SAR)), calcium (Ca++), magnesium (mg^{++}), sulfate (SO_4^-), carbonate (CO_3^-), bicarbonate (HCO_3^-), sodium (Na^+) and chloride (Cl^-) as suggested by Saglam [21]. Water samples were collected from the running wells with great care. The amount of sample was 2 L.. The samples were placed on the clean plastic bottles. Those bottles were rinsed thrice by same irrigation water. Prior to the water samples collecting, well were run about 20 or 30 minutes. Bottles were closed and labeled with accurately. Soil samples were taken from 0-30 cm soil depth in examined plastic houses in October 2011.

III. RESULTS AND DISCUSSION

The depth of the examined wells varied from 25 m to 42 m. Tomato production is intensive and the production area of those plastic houses was in the range of between 0.1 and 0.75 ha. The farmers in general were primary school education. The results of the pH and EC values of water samples obtained during the periods October 2011-May 2012 was presented at Table 1. The status of the samples with respect to pH, EC, anion-cation, SAR, %Na, boron content and water quality class just for October have been given at Table 2.

In table 1, the values of EC were ranged from 440 to 2100 µmhos/cm and overall water samples of wells nearby sea using irrigation of plastic house 7 and 8 were unfit for irrigation. Water samples of pH values were within the safe limits as 6.5 and 8.5 [22] and overall they varied from 7.15 and 8.05.

In Table 2, pH values were ranged rom 7.15 and 8.03. The EC and boron contents varied from 437 to 2103 µmhos/cm and from 0.00 to 0.02 ppm, respectively. In examine the soluble anion and cation, Na^+ and Cl^- were highly dominant and SAR varied from 0.87 to 3.68. Overall, about 30% and 70% of water samples were second class (C_2) and third class (C_3) in regard to United State Salinity Laboratory, USSL, standard, respectively.

As seen table 2, irrigation water quality varied from C_2S_1 to C_3S_1. There is tendency of salinity of groundwater in region. The irrigation water of C_2S_1 having moderate saline with low sodium can be used safely in irrigation without salinity or soil management. Under low infiltration rate of soils such as clay textured, leaching requirement is needed for crops having sensitive to the soil salinity. By using C_3S_1 class irrigation water may result salinity problem in soils in future.

Soil characteristics particularly soil water intake has very important role to play in soil salinization. Soil texture was performed and saturation percentage affected by texture was determined (Table 3).

Table 1. Status of water samples in respect to pH and EC (µmhos/cm)

Well No	Parameters	October	November	December	January	February	March	April	May
1	**pH**	7.62	7.67	7.72	7.64	7.69	7.72	7.72	7.74
	EC	983	976	982	991	998	1019	1039	1046
2	**pH**	7.31	7.36	7.40	7.35	7.45	7.38	7.41	7.43
	EC	1199	1209	1214	1185	1193	1201	1203	1220
3	**pH**	7.20	7.26	7.28	7.22	7.33	7.24	7.36	7.35
	EC	1307	1310	1321	1307	1300	1327	1334	1345
4	**pH**	7.76	7.77	7.79	7.74	7.82	7.73	7.75	7.78
	EC	688	688	694	701	712	722	739	756
5	**pH**	8.03	8.02	8.02	8.03	8.03	8.02	8.02	**8.05**
	EC	510	500	497	551	583	611	632	636
6	**pH**	8.00	8.01	8.03	8.00	8.01	8.03	8.02	8.02
	EC	**437**	445	462	470	473	484	478	486
7	**pH**	**7.15**	7.19	7.22	7.25	7.36	7.25	7.31	7.35
	EC	1811	1795	1791	1773	1825	1952	1959	1973
8	**pH**	7.85	7.86	7.80	7.88	8.00	7.96	8.00	**8.05**
	EC	2103	2060	2075	2060	2054	2081	**2090**	**2090**
9	**pH**	7.43	7.45	7.49	7.42	7.56	7.46	7.53	7.56
	EC	1050	1065	1053	1071	1071	1072	1080	1086
10	**pH**	7.30	7.33	7.43	7.39	7.48	7.35	7.41	7.43
	EC	1058	1085	1100	1122	1145	1151	1142	1154

Table 2. Chemical Properties of Water Samples

Well No	pH	ECx10^6 µmhos/cm	Soluble Ions in Water										SAR	%Na	Class	Boron (ppm)
			Cations (me/L)					Anions (me/L)								
			Na^+	K^+	Ca^{++}	Mg^{++}	Total	$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Total				
1	7.62	983	2.72	0.38	3.75	2.87	9.72	-	1.78	3.94	3.64	9.36	1.31	28.0	C_3S_1	0.01
2	7.31	1199	4.54	0.42	2.76	2.83	10.55	-	1.82	4.83	3.79	10.44	1.62	43.0	C_3S_1	0.01
3	7.20	1307	5.32	0.69	3.63	2.34	11.98	-	1.62	4.76	4.63	11.01	1.78	44.4	C_3S_1	0.00
4	7.76	688	3.10	0.40	2.78	1.07	7.35	-	1.50	3.88	2.87	8.25	1.61	42.2	C_2S_1	0.00
5	8.03	510	1.34	0.53	1.27	1.78	4.92	-	0.31	2.56	2.66	5.53	0.87	27.2	C_2S_1	0.00
6	8.00	437	1.36	0.25	1.27	1.59	4.47	-	1.44	1.25	2.57	5.26	0.95	30.4	C_2S_1	0.00
7	7.15	1811	8.88	0.57	4.71	2.88	17.04	-	1.72	10.81	3.76	16.29	2.33	52.1	C_3S_1	0.00
8	7.85	2103	12.4	0.60	4.56	2.17	19.73	-	1.34	13.58	4.75	19.67	3.68	62.8	C_3S_1	0.02
9	7.43	1050	3.60	0.63	3.79	2.16	10.18	-	1.44	4.94	3.72	10.10	1.21	35.4	C_3S_1	0.00
10	7.30	1058	4.29	0.54	3.38	2.49	10.70	-	1.52	4.76	3.84	10.12	1.46	40.0	C_3S_1	0.00

Table 3. Texture and Saturation Content of Soils in 30 cm Soil Depth

Sample No	Location	Saturation Content %	Sand %	Clay %	Silt %	Texture Class
1	Dervişli	59.38	19.6	35	45.4	SCL
2	Bahçe	73.40	25.6	33	41.4	CL
3	Gülümpaşalı	51.13	49.6	19	31.4	L
4	Sökün	59.80	53.6	7	39.4	SL
5	Arkum	58.55	33.6	33	33.4	CL
6	Gaziçiftliği	58.96	29.6	37	33.4	CL
7	Kapızlı	54.43	37.6	31	31.4	CL
8	Olukbaşı	51.95	51.6	27	21.4	SCL
9	Sarıcalar	59.79	27.6	29	43.4	CL
10	Kabasakallı	51.13	43.6	15	41.4	L

In examined soils, saturation content and soil texture were ranged from about 51% to 73% and from Sandy-Clay-Loam (SCL) to Clay-Loam (CL), respectively.

In examined soils, pH values of soils were ranged from 7.36 to 7.66. Those values were in safe limits in accordance of pH. In overall, the lowest EC as 985 µmhos/cm and maximum as 2430 µmhos/cm values were obtained from the Arkum (Site 5) and Kapızlı (Site 7), respectively. Soils in plastic houses have not reached to the threshold limit of 4000 µmhos/cm so there is no salinity problem in soils. Dominant soluble cations and anion in water were Na^{+}, Ca^{++} and $SO4^{=}$ ' respectively. The status of Cation Exchange Capacity, CEC, and Exchangeable Sodium Percentage, ESP, varied from 12.47 to 17.89 me/100g and from 2.03% to 14.69%, respectively. Overall ESP values were lower than the threshold limit (< 15%) so there is no alkaline problem in soils.

IV. CONCLUSION

In overall, EC values of groundwater using in irrigation of vegetables of plastic houses was found greater than the safe limits of 750 µmhos/cm so those groundwater should be used in irrigation with great care. In addition, an adequate drainage is needed. Fortunately, although using the saline water for irrigation purpose of vegetables, none soil salinity problem was detected. Even no problem in current, salinization problem may occur in future in case using that water without well management. Therefore, addition of fresh to the water supplies or application of water to the crops more than water requirement, for leaching, is a good alternative practical solution to control soil salinity. Groundwater is the single water supply for irrigation and irrigation water quality is vital important for sustainable agro-production so it can not be allowed to be contaminated via some contaminants.

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